What is claimed is:

1. An apparatus for inspecting a wafer or a reticle, comprising:

   a) means for exposing said wafer or said reticle to an influx of photons, said photons having an energy selected to cause photoelectrons to leave said wafer or said reticle,

   b) electron optics for focusing said photoelectrons in the plane of a detection means, and

   c) means for detecting said photoelectrons, thereby imaging a portion of said wafer or said reticle.

2. The apparatus of Claim 1, wherein said means for exposing said substrate to an influx of photons is a laser.

3. The apparatus of Claim 1, wherein said means for exposing substrate to an influx of photons is an arc lamp.

4. The apparatus of Claim 1, wherein said means for detecting said photoelectrons is a charge-coupled device.

5. The apparatus of Claim 1, wherein said means for detecting said photoelectrons is a TDI sensor.

6. The apparatus of Claim 1, further comprising a means for converting said photoelectrons to photons.

7. The apparatus of Claim 1, wherein said means for converting said photoelectrons to photons is a scintillating material.

8. The apparatus of Claim 1, wherein said means for converting said photoelectrons to photons is a phosphorescent material.

9. A method of imaging a wafer or a reticle to find defects, comprising:

a) exposing said wafer or said reticle to an influx of photons, said photons having an energy selected to cause photoelectrons to leave the surface of said wafer or said reticle,

b) focusing said photoelectrons to create an image of said wafer or said reticle in the plane of a detector, and

c) detecting said photoelectrons, thereby imaging a portion of said wafer or said reticle.

10. The method of Claim 9, further comprising:

d) processing the image to detect defects or to classify defects.

11. The method of Claim 10, wherein

a) said wafer or reticle comprises at least two materials, and

b) said photons have an energy selected to increase the difference in photoelectron yield between at least two of said materials.

12. The method of Claim 10, wherein said influx of photons is oriented at a 90 degree angle to the substrate.

13. The method of Claim 10, wherein said influx of photons is oriented at an angle of less than 90 degrees to the substrate.

14. The method of Claim 10, wherein said influx of photons is vertically polarized.

15. The method of Claim 10 wherein said influx of photons is horizontally polarized.

16. An apparatus for imaging a substrate, comprising:

a) means for exposing said substrate to an influx of photons, said photons having an energy selected to cause photoelectrons to leave said substrate,

b) means for exposing said substrate to an influx of electrons, said electrons having both an energy and a current density profile selected to

maintain surface charge present on said substrate at a predetermined level,

c) imaging electron optics for focusing said photoelectrons in the plane of a detector, and

d) means for detecting said photoelectrons, thereby imaging a portion of said substrate.

17. The apparatus of Claim 16, wherein said means for exposing said substrate to an influx of photons is a laser.

18. The apparatus of Claim 16, wherein said means for exposing substrate to an influx of photons is an arc lamp.

19. The apparatus of Claim 16, wherein said means for detecting said photoelectrons is a charge-coupled device.

20. The apparatus of Claim 16, wherein said means for detecting said photoelectrons is a TDI sensor.

21. The apparatus of Claim 16, further comprising a means for converting said photoelectrons to photons.

22. The apparatus of Claim 21, wherein said means for converting said photoelectrons to photons is a scintillator.

23. The apparatus of Claim 21, wherein said means for converting said photoelectrons to photons is a phosphorescent material.

24. The apparatus of Claim 16, further comprising:

a) means for selecting most or all of said photoelectrons, or a portion of said photoelectrons, and rejecting most or all of said electrons reflected from said substrate.

25. The apparatus of Claim 24, wherein said means for selecting most or all of said photoelectrons, or a portion of said photoelectrons, and rejecting most

or all of said reflected electrons is a filter which selects said photoelectrons and rejects said reflected electrons based on the angular distribution of said photoelectrons and reflected electrons.

26. The apparatus of Claim 25, wherein said filter includes a blocking means containing a shaped aperture.

27. The apparatus of Claim 16, further comprising:

    a) means for detecting electrons reflected from the surface of said substrate, thereby imaging a portion of said substrate.

28. The apparatus of Claim 27, wherein said means for detecting said reflected electrons is a charge-coupled device.

29. The apparatus of Claim 27, wherein said means for detecting said reflected electrons is a TDI sensor.

30. The apparatus of Claim 27, further comprising a means for converting said reflected electrons to photons.

31. The apparatus of Claim 30, wherein said means for converting said reflected electrons to photons is a scintillator.

32. The apparatus of Claim 30, wherein said means for converting said reflected electrons to photons is a phosphorescent material.

33. The apparatus of Claim 27, further comprising:

    a) means for selecting said most or all of electrons reflected from the substrate, or a portion of said reflected electrons, and rejecting most or all of said photoelectrons.

34. The apparatus of Claim 33, wherein said means for selecting most or all of said reflected electrons, or a portion of said reflected electrons, and rejecting most or all of said photoelectrons is a filter which selects said reflected

electrons and rejects said photoelectrons based on the angular distribution of said reflected electrons and photoelectrons.

35. The apparatus of Claim 34, wherein said filter includes a blocking means containing a shaped aperture.

36. A method of imaging a substrate, comprising:

    a) exposing said substrate to an influx of photons, said photons having an energy selected to cause photoelectrons to leave said substrate,

    b) exposing said substrate to an influx of electrons, said electrons having both an energy and a current density profile selected to maintain surface charge present on said substrate at a predetermined level,

    c) focusing said photoelectrons to create an image of said substrate in the plane of a detector, and

    d) detecting said photoelectrons, thereby imaging a portion of said substrate.

37. The method of Claim 36, wherein

    a) said substrate comprises at least two materials, and

    b) said photons have an energy selected to increase the difference in photoelectron yield between at least two of said materials.

38. The method of Claim 36, wherein said substrate is concurrently exposed to said influx of photons and said influx of electrons.

39. The method of Claim 36, wherein said substrate is alternately exposed to said influx of photons and said influx of electrons.

40. The method of Claim 36, wherein said substrate is exposed to said influx of photons over a first area, said substrate is exposed to said influx of electrons over a second area, and said first area is substantially contained within said second area.

41. The method of Claim 36, further comprising the additional step interposed between step b) and step c):

    a) filtering the flux of photoelectrons and electrons reflected from the surface of said substrate in order to select said photoelectrons, or a portion of said photoelectrons, and to reject most or all of said reflected electrons.

42. The method of Claim 37, wherein said filtering is achieved by selecting said photoelectrons based on their angular distribution from said surface of said substrate.

43. The method of Claim 36, wherein

    a) said surface of said substrate comprises at least two materials, and

    b) said photons have an energy selected to increase the difference in photoelectron yield between at least two of said materials.

44. The method of Claim 36, wherein said influx of photons is oriented at a 90 degree angle to the substrate.

45. The method of Claim 36, wherein said influx of photons is oriented at an angle of less than 90 degrees to the substrate.

46. The method of Claim 36, wherein said influx of photons is vertically polarized.

47. The method of Claim 36 wherein said influx of photons is horizontally polarized.

48. A method of imaging a substrate, comprising:

    a) exposing said substrate to an influx of photons, said photons having an energy selected to cause photoelectrons to leave said substrate,

    b) exposing said substrate to an influx of electrons, said electrons having both an energy and a current density profile selected to maintain surface charge present on said substrate at a predetermined level,

c) focusing the portion of said influx of electrons which are reflected from said substrate to create an image of said substrate in the plane of a detector, and

d) detecting the portion of said influx of electrons which are reflected from said substrate, thereby imaging a portion of said substrate.

49. The method of Claim 48, wherein said substrate is concurrently exposed to said influx of photons and said influx of electrons.

50. The method of Claim 48, wherein said substrate is alternately exposed to said influx of photons and said influx of electrons.

51. The method of Claim 48, wherein said substrate is exposed to said influx of photons over a first area, said substrate is exposed to said influx of electrons over a second area, and said first area is substantially contained within said second area.

52. The method of Claim 48, further comprising the following step, interposed between step b) and step c):

a) filtering the flux of photoelectrons and electrons reflected from the surface of said substrate in order to select said reflected electrons, or a portion of said reflected electrons, and to reject most or all of said photoelectrons.

53. The method of Claim 52, wherein said filtering is achieved by selecting said reflected electrons, or a portion of said reflected electrons, based on their angular distribution from the surface of said substrate.

54. The method of Claim 53 wherein said filtering rejects most or all reflected electrons which are reflected at or near the specular angle and selects most or all reflected electrons which are scattered away from the specular angle.

55. A method of imaging a substrate, comprising:

a) exposing said substrate to an influx of photons, said photons having an energy selected to cause photoelectrons to leave said substrate,

b) exposing said substrate to an influx of electrons, said electrons having both an energy and a current density profile selected to maintain surface charge present on said substrate at a predetermined level,

c) focusing the portion of said influx of electrons which are reflected from the surface of said substrate in the plane of a detector,

d) focusing said photoelectrons in the plane of a detector, and

e) detecting said photoelectrons and reflected electrons, thereby imaging a portion of said substrate.

56. The method of Claim 55, further comprising:

a) filtering said reflected electrons and said photoelectrons to reject most or all of said reflected electrons which are reflected at or near the specular angle and most or all of said photoelectrons which are emitted perpendicular to the surface of the substrate, and to select most or all of said reflected electrons which are scattered away from the specular angle and/or most or all of said photoelectrons which are emitted at angles other than perpendicular to the surface of the substrate.

57. A method of identifying the chemical composition of a defect on a wafer or a reticle, comprising:

a) exposing said defect to an influx of photons, said photons having an energy below the energy required to cause photoelectrons to leave said defect,

b) increasing the energy of said photons in discrete steps,

c) monitoring the photoelectron yield from said defect after each step, and

d) identifying the chemical composition of said defect on the basis of the photon energy at which said photoelectron yield increases substantially.

58. An apparatus for imaging a substrate, comprising:

a) means for exposing said substrate to an influx of relatively high-energy electrons, said high-energy electrons having an energy selected to cause secondary electrons to leave said substrate,

b) means for exposing said substrate to an influx of relatively low-energy electrons, said low-energy electrons having both an energy and a current density profile selected to maintain surface charge present on said substrate at a predetermined level,

c) means for selecting most or all of said secondary electrons, or a portion of said secondary electrons, and rejecting most or all of said relatively low-energy electrons reflected from said substrate, and

d) means for detecting said secondary electrons, thereby imaging a portion of said substrate.

59. The apparatus of Claim 58, wherein said means for selecting said secondary electrons and rejecting said reflected low-energy electrons includes a filter which selects most or all of said secondary electrons and rejects most or all of said reflected low-energy electrons based on the angular distribution of said secondary electrons and said reflected low-energy electrons.

60. The apparatus of Claim 59, wherein said filter includes a blocking means containing an aperture.

61. A method of imaging a substrate, comprising:

a) exposing said substrate to an influx of relatively high-energy electrons, said high-energy electrons having an energy selected to cause secondary electrons to leave said substrate,

b) exposing said substrate to an influx of relatively low-energy electrons, said electrons having both an energy and a current density profile selected to maintain surface charge present on said substrate at a predetermined level,

c) filtering the flux of said secondary electrons and said low-energy electrons reflected from the surface of said substrate in order to select most or all of said secondary electrons, or a portion of said secondary electrons, and to reject most or all of said reflected electrons,

d) focusing said secondary electrons to create an image of said substrate in the plane of a detector, and

e) detecting said secondary electrons, thereby imaging a portion of said substrate.

62. The method of Claim 61, wherein said filtering is achieved by selecting said secondary electrons, or a portion of said secondary electrons, based on their angular distribution from the surface of said substrate.

63. An apparatus for imaging a substrate, comprising:

a) means for exposing said substrate to an influx of relatively high-energy electrons, said high-energy electrons having an energy selected to cause secondary electrons to leave said substrate,

b) means for exposing said substrate to an influx of relatively low-energy electrons, said low-energy electrons having both an energy and a current density profile selected to maintain surface charge present on said substrate at a predetermined level,

c) means for selecting most or all of said low-energy electrons reflected from said substrate, or a portion of said low-energy electrons reflected from said substrate, and rejecting most or all of said secondary electrons, and

d) means for detecting said reflected low-energy electrons, thereby imaging a portion of said substrate.

64. The apparatus of Claim 63, wherein said means for selecting said reflected low-energy electrons and rejecting said secondary electrons is a filter which selects said reflected low-energy electrons and rejects said secondary electrons based on the angular distribution of said reflected low-energy electrons and said secondary electrons.

65. The apparatus of Claim 64, wherein said filter includes a blocking means containing an aperture.

66. A method of imaging a substrate, comprising:

a) exposing said substrate to an influx of relatively high-energy electrons, said high-energy electrons having an energy selected to cause secondary electrons to leave said substrate,

b) exposing said substrate to an influx of relatively low-energy electrons, said electrons having both an energy and a current density profile selected to maintain surface charge present on said substrate at a predetermined level,

c) filtering the flux of said secondary electrons and said low-energy electrons reflected from the surface of said substrate in order to select most or all of said reflected low-energy electrons, or a portion of said reflected low-energy electrons, and to reject most or all of said secondary electrons,

d) focusing said reflected low-energy electrons to create an image of said substrate in the plane of a detector, and

e) detecting said reflected low-energy electrons, thereby imaging a portion of said substrate.

67. The method of Claim 66, wherein said filtering is achieved by selecting said reflected low-energy electrons, or a portion of said reflected low-energy electrons, based on their angular distribution from the surface of said substrate.

68. The method of Claim 58 wherein said filtering rejects most or all of said reflected low-energy electrons which are reflected at or near the specular angle and selects most or all of said reflected low-energy electrons which are scattered away from the specular angle.

69. A method of imaging a substrate, comprising:

a) exposing said substrate to an influx of relatively high-energy electrons, said high-energy electrons having an energy selected to cause secondary electrons to leave said substrate,

b) exposing said substrate to an influx of relatively low-energy electrons, said electrons having both an energy and a current density profile

selected to maintain surface charge present on said substrate at a predetermined level,

c) filtering said secondary electrons and the portion of said relatively low-energy electrons which are reflected from the surface of said substrate, in order to select most or all of said secondary electrons which are emitted at angles other than perpendicular to the substrate and most or all of said reflected electrons which are scattered away from the specular angle, and to reject most or all of said secondary electrons which are emitted at an angle perpendicular to the substrate and most or all of said reflected electrons which are scattered at the specular angle,

d) focusing said selected secondary electrons and said selected reflected electrons to create an image of said substrate in the plane of a detector,

e) detecting said selected secondary electrons and said selected reflected electrons, thereby imaging a portion of said substrate.